CLV-81

THE STANDARD OIL COMPANY
OFFICE CORRESPONDENCE

June 7, 1984

T. P. Schur
928 T. T.

According to our conversation with Fred Hepler, I would like you to prepare a simple letter agreement outlining our relationship for testing water stress in corn. Attached is a meeting memo that Bronson Gardner had with Fred for your information and use in drafting the agreement.

We would also need to have a similar agreement for Benson Lake Farms, Inc., P. O. Box 586, De Witt, Arkansas 72042. George Dunklin, Jr., is the owner, and Brad Boyd is Farm Manager.

Herbert D. Knudsen

HDK/ej
0652Q

cc: Bronson Gardner ✓

Attachment

CLV-41

THE STANDARD OIL COMPANY
OFFICE CORRESPONDENCE

RECEIVED

May 25, 1984

Memorandum

Nebraska Trip: May 13-20, 1984

Fred Hepler Irrigation Scheduling Experiment

I met with Fred Hepler to discuss the feasibility of using an infrared thermometer to schedule irrigations on a center pivot. Dr. Blaine Blad (from the University of Nebraska) also participated in the discussion.

Several points were clarified.

1. Fred is willing to work with us. The potential for improving his irrigation scheduling is there.

2. A contract is needed as soon as possible. The first measurements should be taken around the 15th-20th of June.

3. Two objectives for this technique were defined:

   a. Maximize crop rooting depth. This is done by mildly stressing the crop during vegetative growth, or by taking the crop to the edge of stress. Since the tasseling and pollination period are so critical to end-of-season grain yields, Fred will operate as normal during mid-season.

   b. Starting around the middle of the grain-fill period the second objective is to use the deep root system to efficiently mine the water beneath the pivot. Canopy temperatures will be measured daily throughout the season, even when Fred is irrigating normally.

4. The protocol can be somewhat different for objective 1 than 2. During early vegetative growth, the crop is small, exposing a significant amount of soil to the view of the infrared thermometer, unless individual plant temperatures are measured. This necessitates the measuring of canopy temperatures down the row by an observer. During objective 2, when the crop is at maximum height, canopy temperatures can be measured across a row while an observer stands on top of the center pivot, or carrying the instrument on a very tall pole.

5. This protocol suggests that the best procedure for an automatic system would be to have the infrared thermometer collect canopy temperatures along the rows. The system would therefore not be a t tached to the pivot, although it could still be used to control a pivot, a third objective identified by Fred.

Contact: Fred Hepler
Thunderbolt Farm
Star Route Box 9-A
Bartlett, Nebraska 68622
(402) 482-5236

He can also be contacted at home after 10:00 p.m. or around 4:00 a.m. at:

(402) 336-4899

The data collection procedure is:

1. Divide the pivot into a wet (most recently irrigated) and dry (longest time since irrigation). This is already routinely done by Fred.

2. Establish the mean and standard deviation of canopy temperature for the wet and dry side. Data must be collected only when the sun is unobscured. (See figure 1).

    a. measure canopy temperature for 15 minutes in the wet side (w_1)

    b. measure canopy temperatures for 15 minutes in the dry side (d_1)

    c. measure canopy temperatures for 15 minutes in the dry side (d_2)

    d. measure canopy temperatures for 15 minutes in the wet side (w_2)

    e. steps a-d can be repeated, if desired

3. Calculate the mean and standard deviation of d_1, d_2, w_1, and w_2

4. Compare d_1 with w_1 and d_2 with w_2 (also d_3 with w_3 and d_4 with w_4, if collected). Make a judgement concerning whether to irrigate.

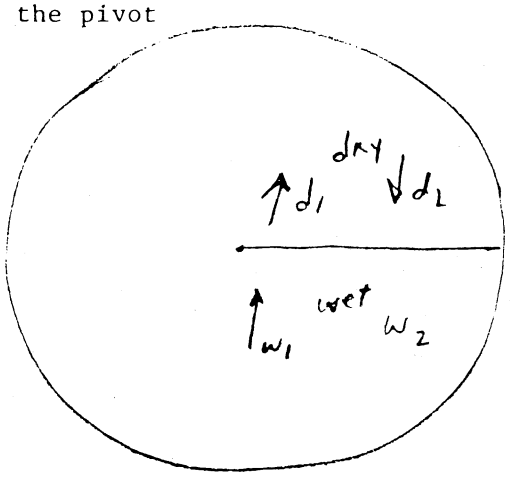
The physical collection of the data is:

a. when the crop is short, the observer walks along a row, pointing the instrument at individual plants. A hand held tape recorder is used to record the numbers

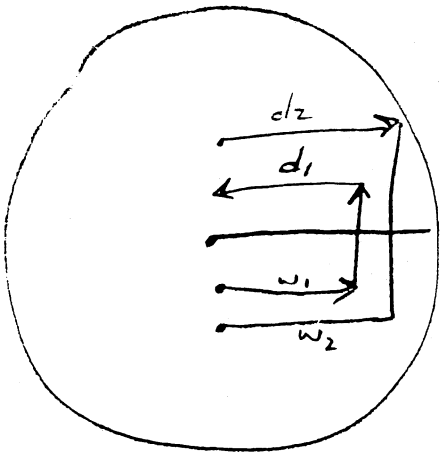
b. when the crop is too tall for hand-measurements, the instrument is mounted on a monopod (similar style as a flag). This necessitates a digital voltmeter be mounted on the monopod so that the instrument output can be monitored.

Figure 1. Schematic of data collection procedure

A. Rows running across the pivot



B. Rows running with the pivot



University of Nebraska Hybrid Evaluation

The seed was planted for our tetraploid hybrid evaluation program. Lack of sufficient S-12 seed resulted in more plots being planted to S-6 than originally planned. There are two irrigation treatments per replication: 100% irrigation (non-stressed) and 33% irrigation (stressed). There is one replication of S-12 and three replications of S-3, S-6, S-57 and Pioneer 3901. Two of the replications for S-3, S-6, S-57 and Pioneer 3901 have 2 neutron tubes per plot (used for soil water balance). In addition, there are also 3 replications of Pioneer 3732. (See Figure 2 and Tables 1 and 2).

Bronson Gardner

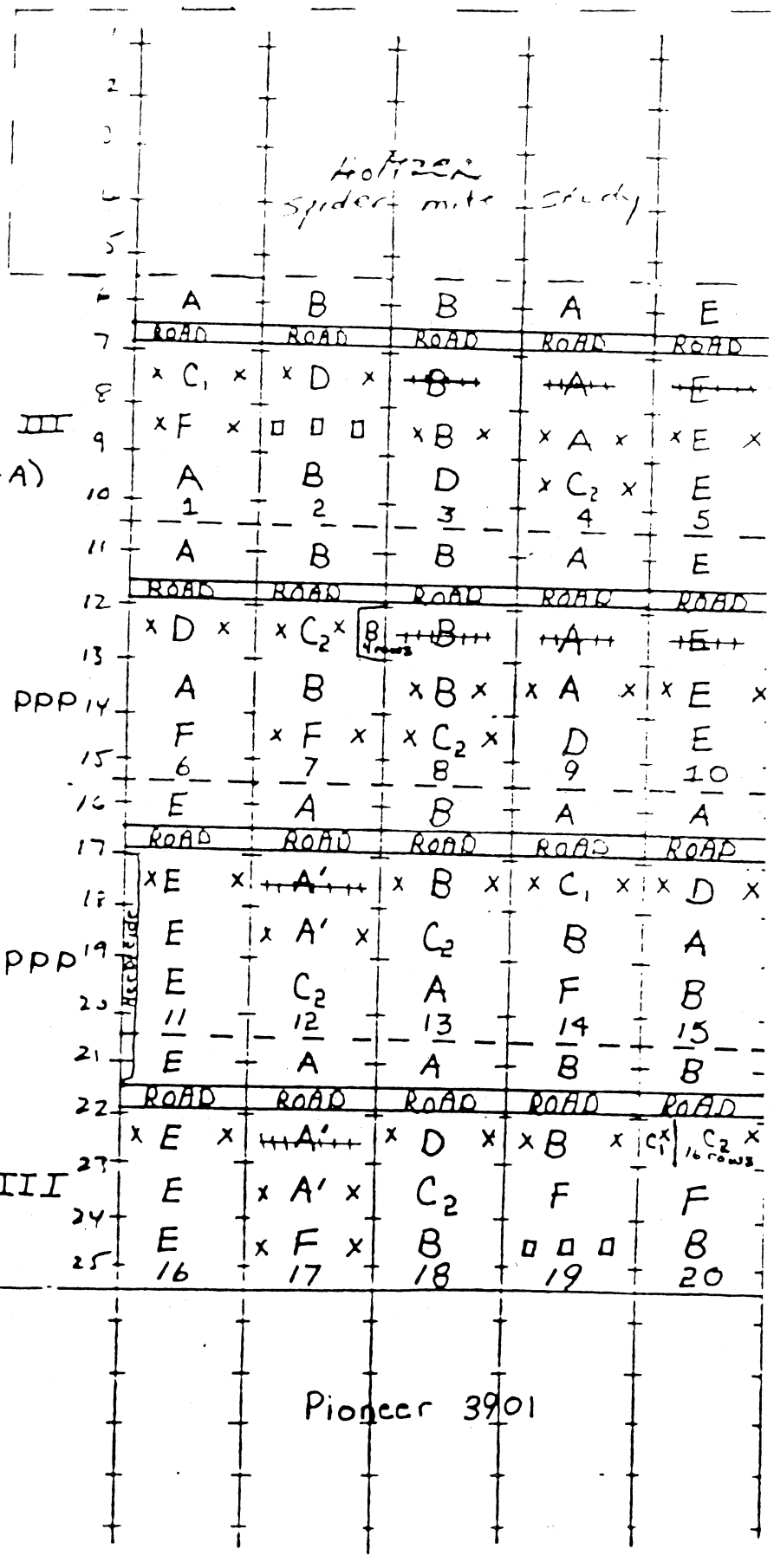
BG:rih

cc: M. E. Keener
S. C. Price
D. S. Hill
H. D. Knudsen
J. D. Burrington
T. E. Rooney

1984 Experimental Design - Final Revision

N ↑

SAL D-AREA



A - Pioneer 3901
A' - Pioneer 3901 (½ pop. of A)
B - B73 - Mo17 (S-57)
C_1 - S12
C_2 - S6
D - S3
E - Soybeans Corsoy
F - Pioneer 3732

Planting rates
A, B, F - 29,900 plants/acre
C_1, C_2, D - 26,000 plants/acre

+++++ Train Tracks
x Neutron Tubes

III - 100% Irrigation
PPP - ⅓ to ½ of III

TABLE 1

Hybrids Planted - SAL May 15-17

Plot	A	B	C	Irrigation TRT
1	S-12	P3732	P3901	FULL
2	S-3	Lysimeter	S-57	FULL
3	S-57	S-57	S-3	FULL
4	P3901	P3901	S-6	FULL
5	Soybeans	Soybeans	Soybeans	FULL
6	S-3	P3901	P3732	PARTIAL
7	S-6 (Last 4 Rows on East are S-57)	S-57	P3732	PARTIAL
8	S-57	S-57	S-6	PARTIAL
9	P3901	P3901	S-3	PARTIAL
10	Soybeans	Soybeans	Soybeans	PARTIAL
11	Soybeans	Soybeans	Soybeans	PARTIAL
12	P3901	P3901	S-6	PARTIAL
13	S-57	S-6	P3901	PARTIAL
14	S-12	S-57	P3732	PARTIAL
15	S-3	P3901	S-57	PARTIAL
16	Soybeans	Soybeans	Soybeans	FULL
17	P-3901	P3901	P3732	FULL
18	S-3	S-6	S-57	FULL
19	S-57	P3732	Lysimeter	FULL
20	Rows Rows 1-8 9-24 =S12 S6	P3732	S-57	FULL

*Planting rates for Pioneer 3901 and S-57 = 29,900 (machine planted)

*Planting rates for S-3, S-6, S-12 = 26,000 plants/acre (hand planted)

*Harvest Row Groups: 5,6,7 · 9,10,11 · 14,15,16 · 18,19,20
3(15 row length) = 45 feet per sample = 4 samples/plot

TABLE 2

Rain gauge/Neutron Tube Locations

	A	B	C
1	2 Tubes	2 Tubes	-------
2	2 Tubes	-------	-------
3	-------	2 Tubes	-------
4	-------	2 Tubes	2 Tubes
5	-------	2 Tubes	-------
6	2 Tubes	-------	-------
7	2 Tubes	-------	2 Tubes
8	-------	2 Tubes	2 Tubes
9	-------	2 Tubes	-------
10	-------	2 Tubes	-------
11	2 Tubes	-------	-------
12	-------	2 Tubes	-------
13	2 Tubes	-------	-------
14	2 Tubes	-------	2 Tubes
15	2 Tubes	-------	-------
16	2 Tubes	-------	-------
17	-------	2 Tubes	2 Tubes
18	2 Tubes	-------	-------
19	2 Tubes	-------	-------
20	2 Tubes	-------	-------

LINDSAY
Lindsay Manufacturing Company
P.O. Box 156
Lindsay, Nebraska 68644
Phone 402-428-2131

Bronson
F.Y.I.
Steve

TO: Steve DeSutter, Sohio

FROM: R.S. Jacobson
Director Eng. Services

SUBJECT: The Scheduler

As promised, I am submitting to you a report on our evaluation of the Scheduler. I was extremely satisfied with the first trial and believe that had our weather conditions been more "on par", we would have shown even more significant results.

In short, I feel confident making two definate statements about the Scheduler:

(1) The Scheduler interprets water stress levels in corn crops well enough to provide irrigation scheduling recommendations as good, or better than, typical scheduling techniques.

(2) The Scheduler provided recommendations to with-hold irrigation when check methods indicated a need. Yet there was no ensueing loss of yield. This would provide an optimum economic yield when using the Scheduler.

Obviously, there were a number of drawbacks to the first unit, which I believe you have adequately addressed. I'll be extremely interested in continuing research and marketing plans in '86.

Regards,

R.S. Jacobson

P.S. - Steve,
The attached data is representative of the records we kept. Didn't feel there was an overwhelming need to detail everything. If so, please advise.

LINDSAY® MEMO

January 6, 1986

TO: Bob Jacobson

FROM: Scott Stuhlmiller

SUBJECT: Performance Summary of Sohio Scheduler

As per your request the following data deals with the performance of the Sohio Scheduler. Lindsay Mfg. Co. started testing this device on July 17, 1985 with the last crop test being made on September 9, 1985. During this time period Dr. Emil E. Pierson visited Lindsay Mfg. Co., to recover data from the scheduler which was sent to Sohio for further evaluation, in addition, Dr. Pierson and I received copies of the data scheduled. Sohio also contacted me weekly to ask routine questions concerning the amount of useage and performance to the scheduler.

Three fields belonging to Mr. Harry Korus, Mr. Mark Foltz and Mr. Richard Beller, were evaluated for crop stress which indicates lack of water. In all 3 cases the fields were planted with corn. Each field was tested daily, weather conditions permitting, between 1:00 P.M. and 4:30 P.M. with an average of 40 to 60 readings taken both stationary and moving. All results of these readings were recorded, and if irrigation was recommended the farmer was notified and the field was irrigated. Note: Due to the amount of rainfall this season irrigation was barely recommended.

In conversing with the farmers involved, the following was indicated:

Mr. Mark Foltz: That both fields had received roughly the same amount of water throughout the year and that crop yield showed no significant difference with both bushels of corn and pounds of silage.

Mr. Harry Korus: Indicated that test field had less water applied compared to check field and that water applied was not applied as timely as it was on the check field. Overall comparison, however, showed that both fields yielded the same, as far as, bushels per acre.

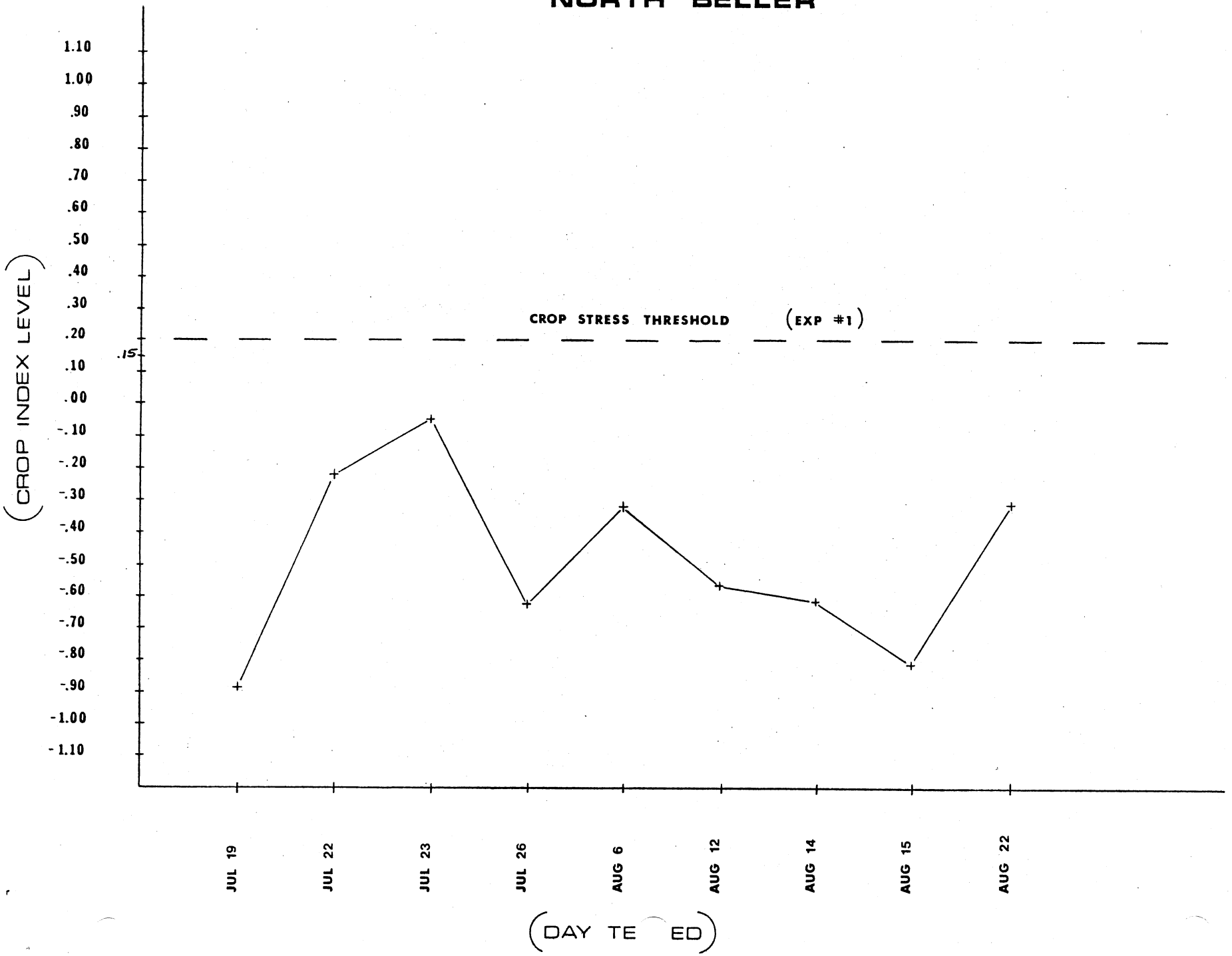
Mr. Richard Beller: Irrigation on test field was kept to a minimal. Crop comparison proved that overall yield was similar.

In summary of the data accumulated by Lindsay Mfg. Co. the Sohio scheduler proved that crop yield was not substantially affected by reduction of water, therefore, decreasing overall irrigation costs. In addition, the Sohio scheduler proved that timely irrigation practices recommended by the scheduling device are accurate and in effect saves money.

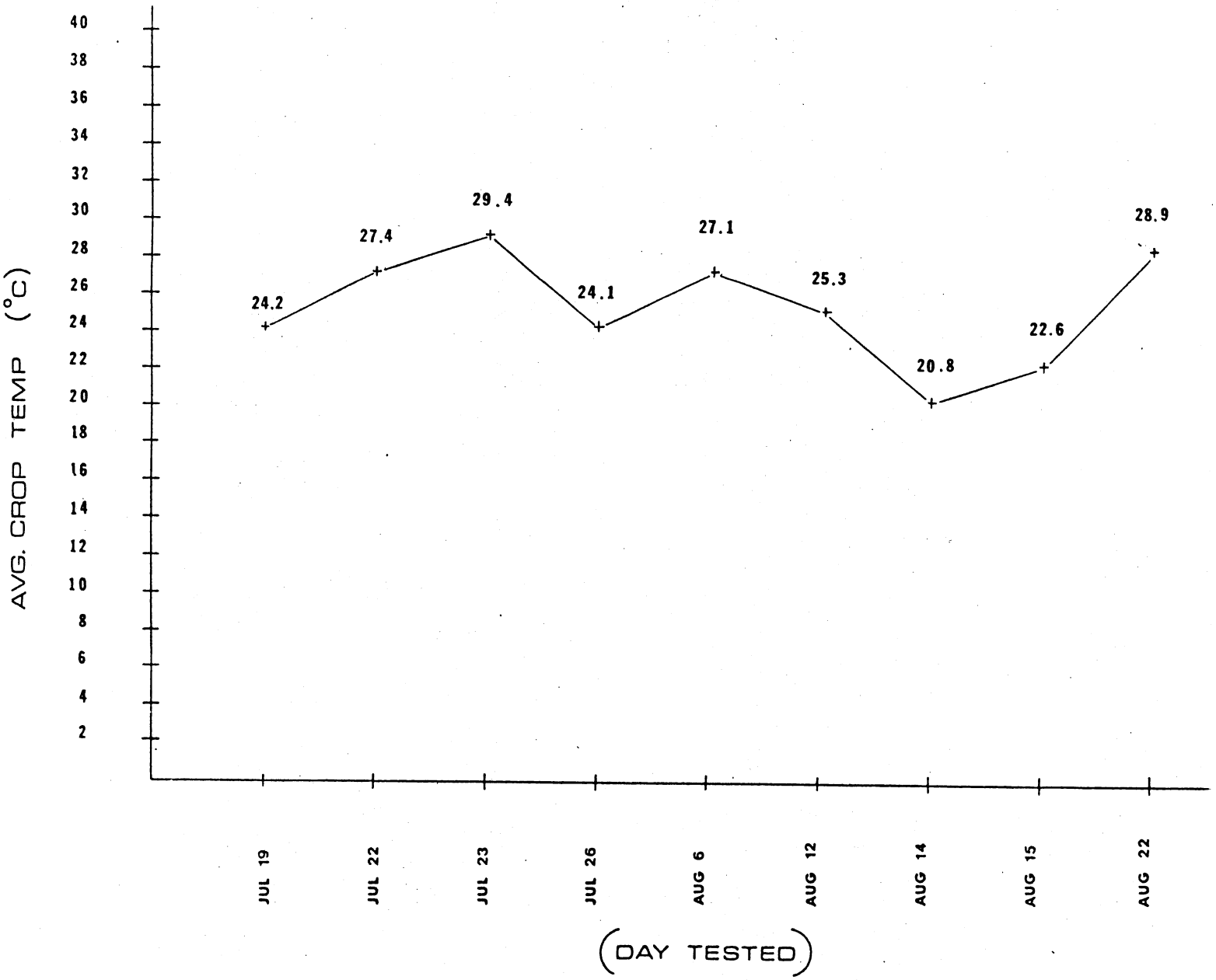
Scott Stuhlmiller

Scott Stuhlmiller
Associate Engineer

NORTH BELLER



NORTH BELLER



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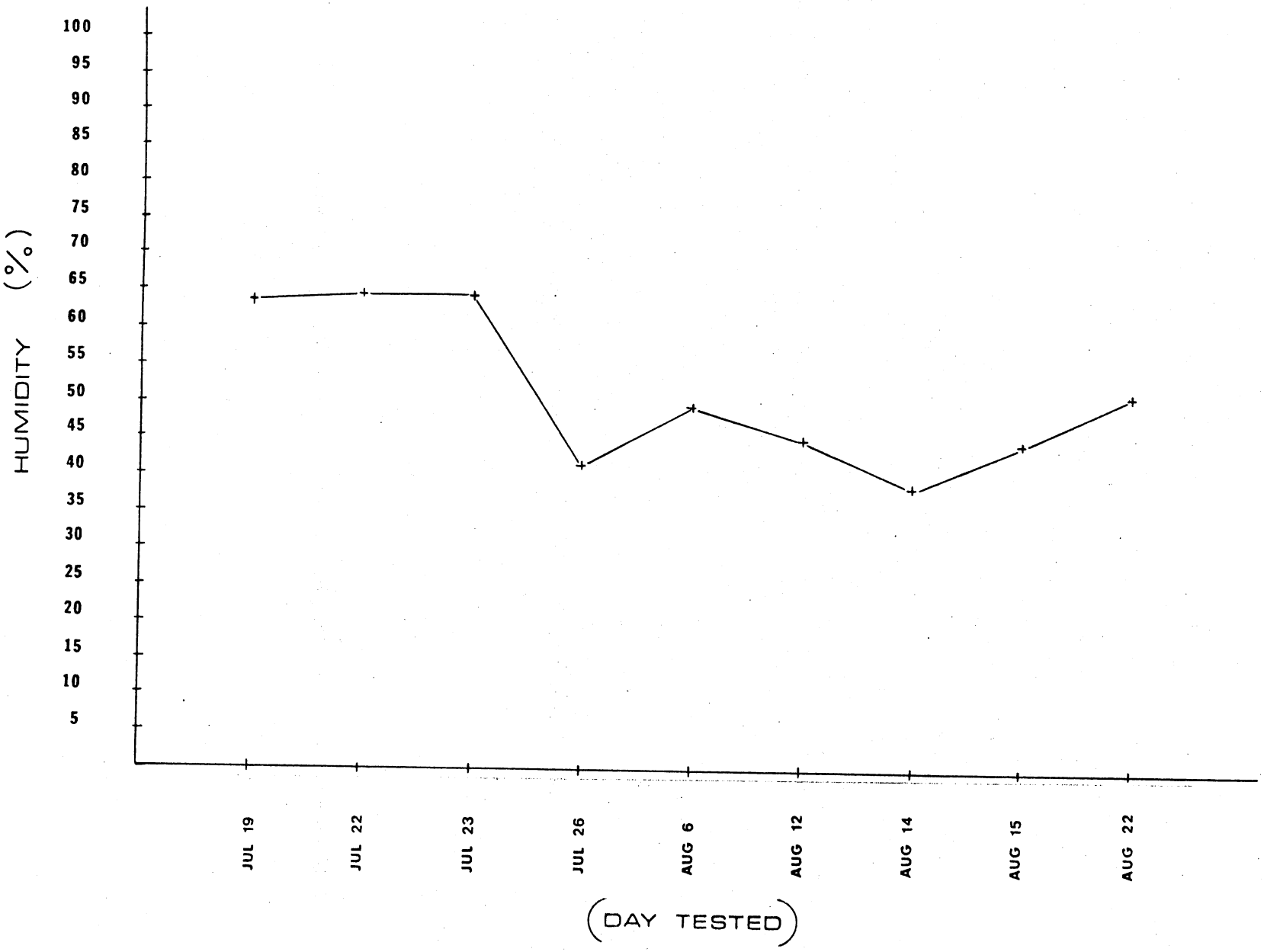

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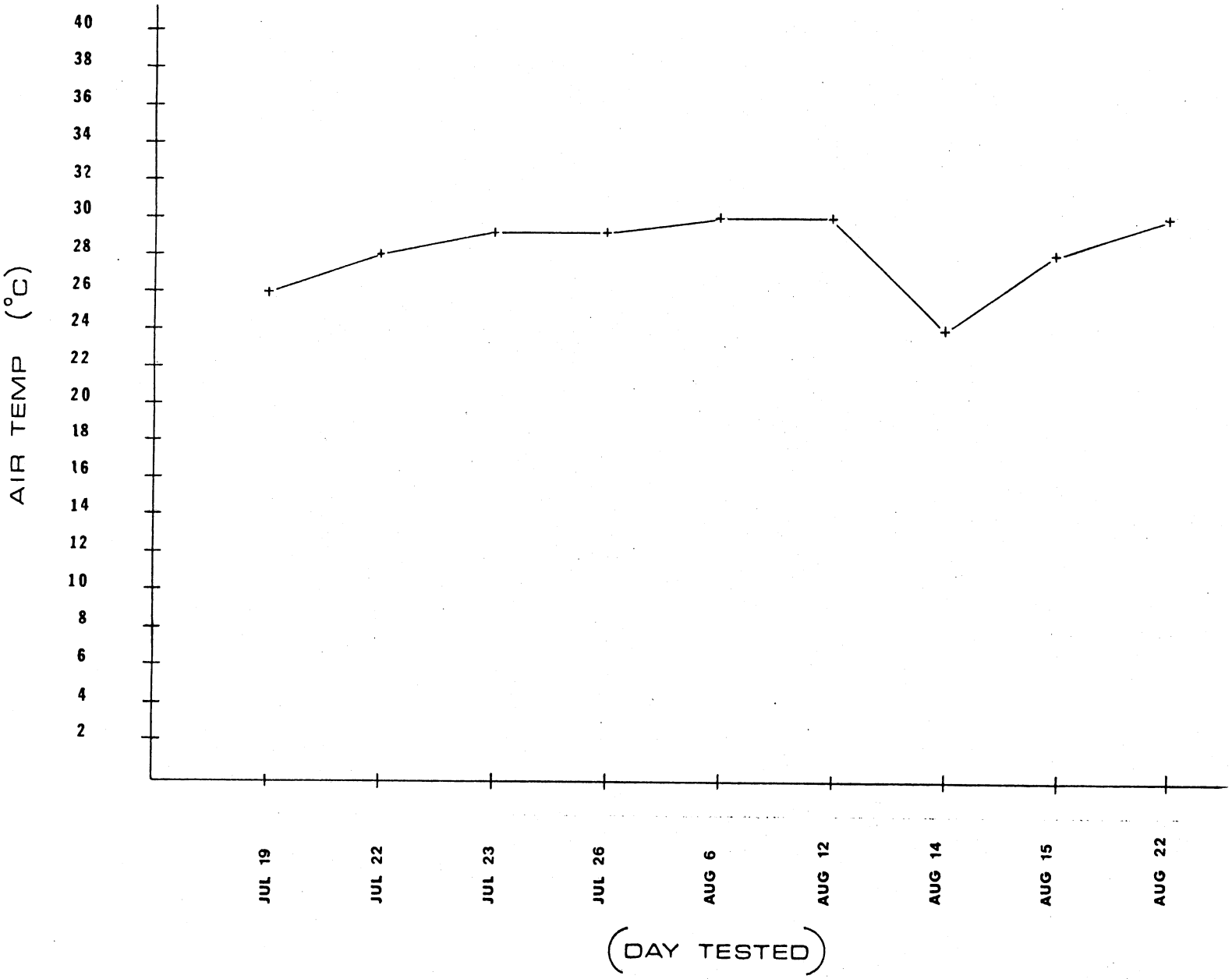

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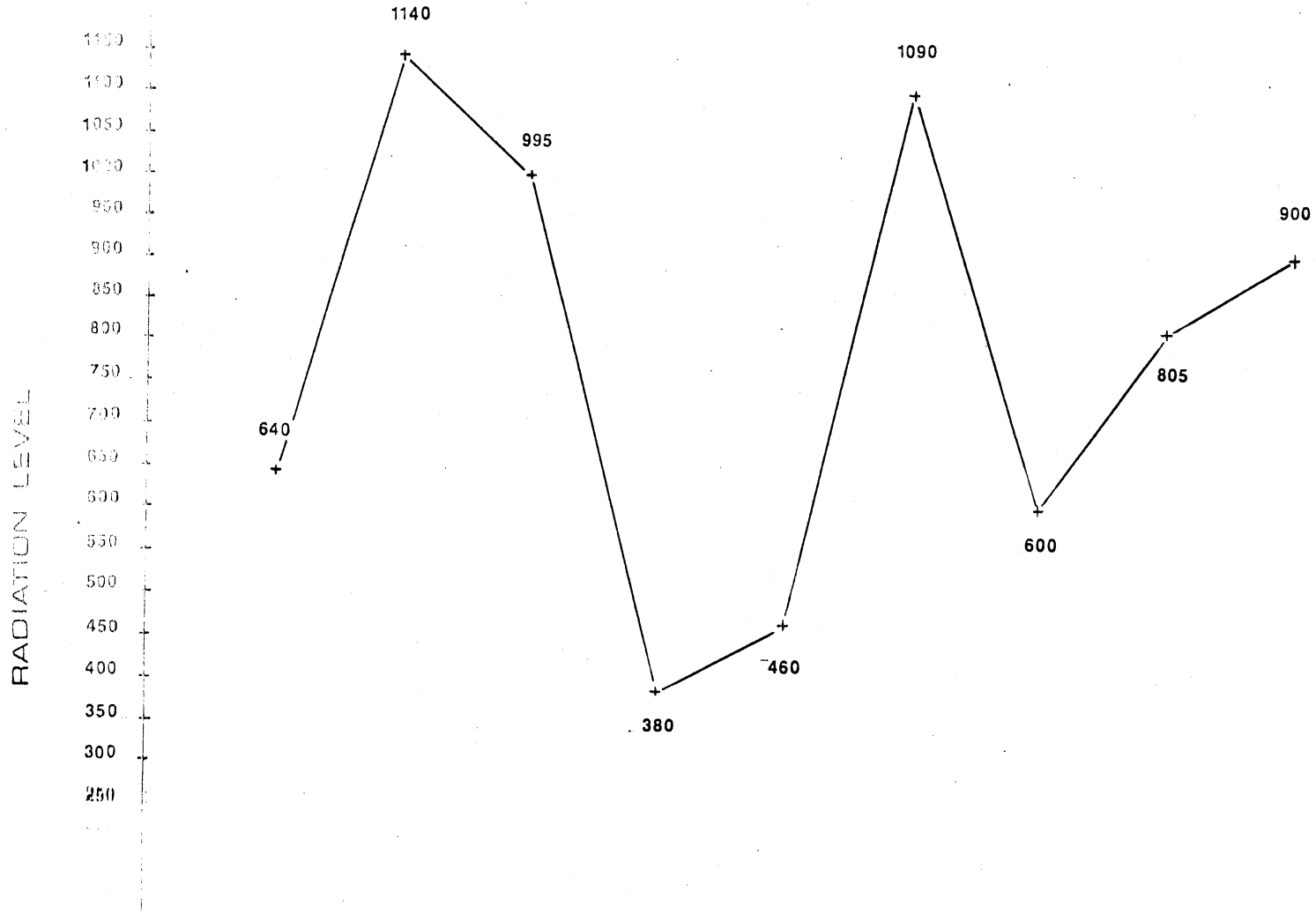
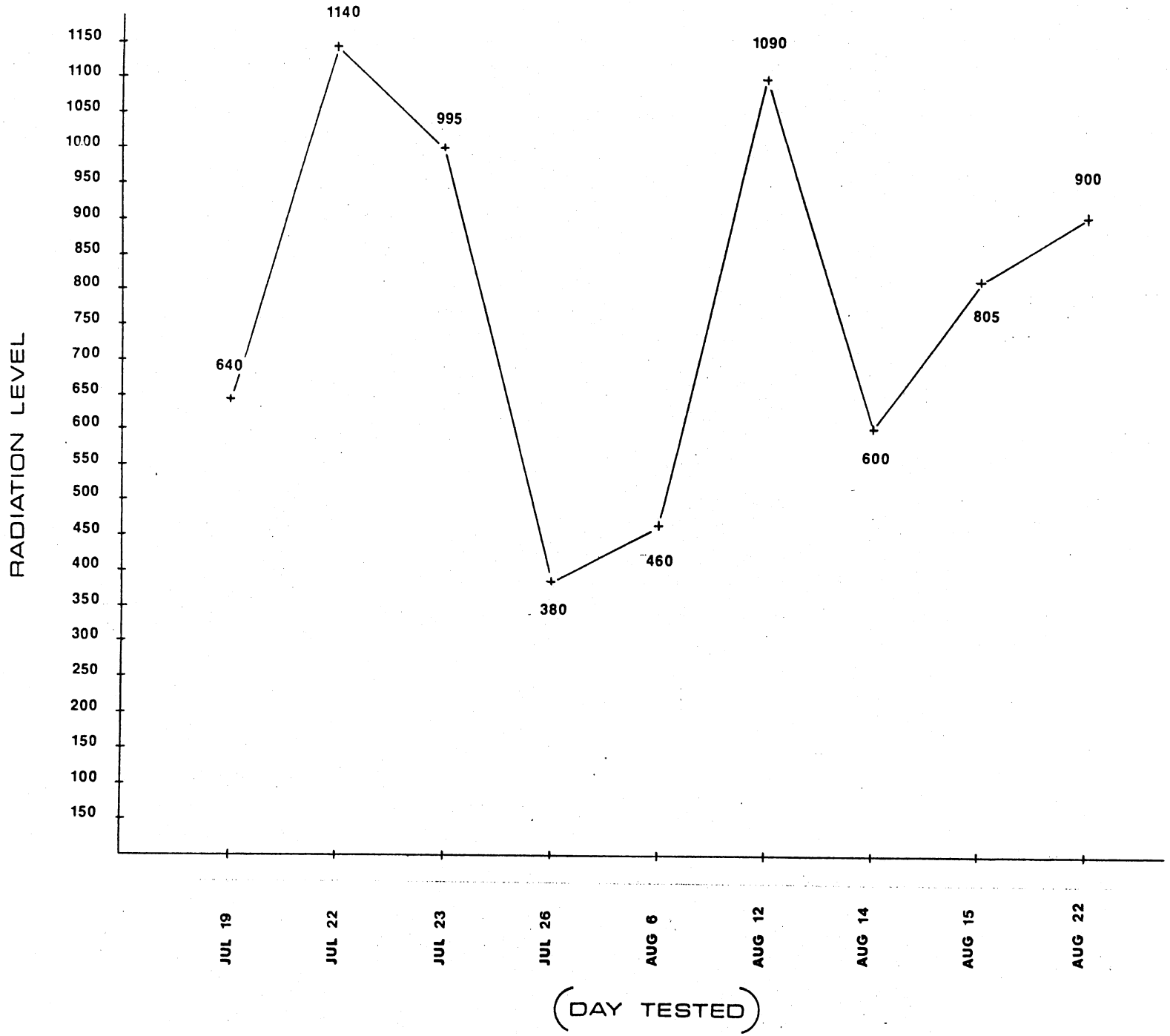


NORTH BELLER



MENU of Programs for the SCHEDULER
SCHEDULER Version 4.0

If you have any difficulty with these programs, phone 1-800-356-0458

6180 COCHRAN ROAD
SOLON,OHIO
1-216-349-6881

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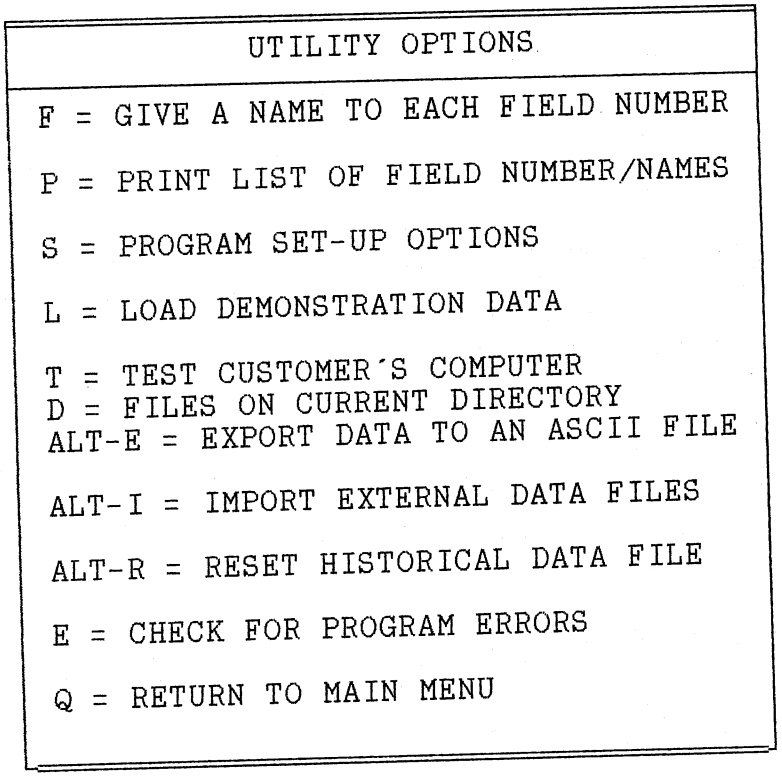
STANDARD OIL ENGINEERED MATERIALS CO.

press any key to continue.

No	Name	Function of the Programs--PRODUCTION Models Only
1	IMPORT	DOWN-LOAD TODAYS DATA TO A TEMPORARY FILE
2	PRINT	PRINT TODAY´S DATA TO THE SCREEN OR A PRINTER
		ANALYSIS OPTIONS
3	TODAY	GRAPH TODAY´S DATA
4	PATTERNS	PATTERNS OF TODAY´S DATA
5	HISTG	GRAPH HISTORICAL FILE
6	HISTP	PRINT HISTORICAL FILE
U	UTIL	UTILITIES

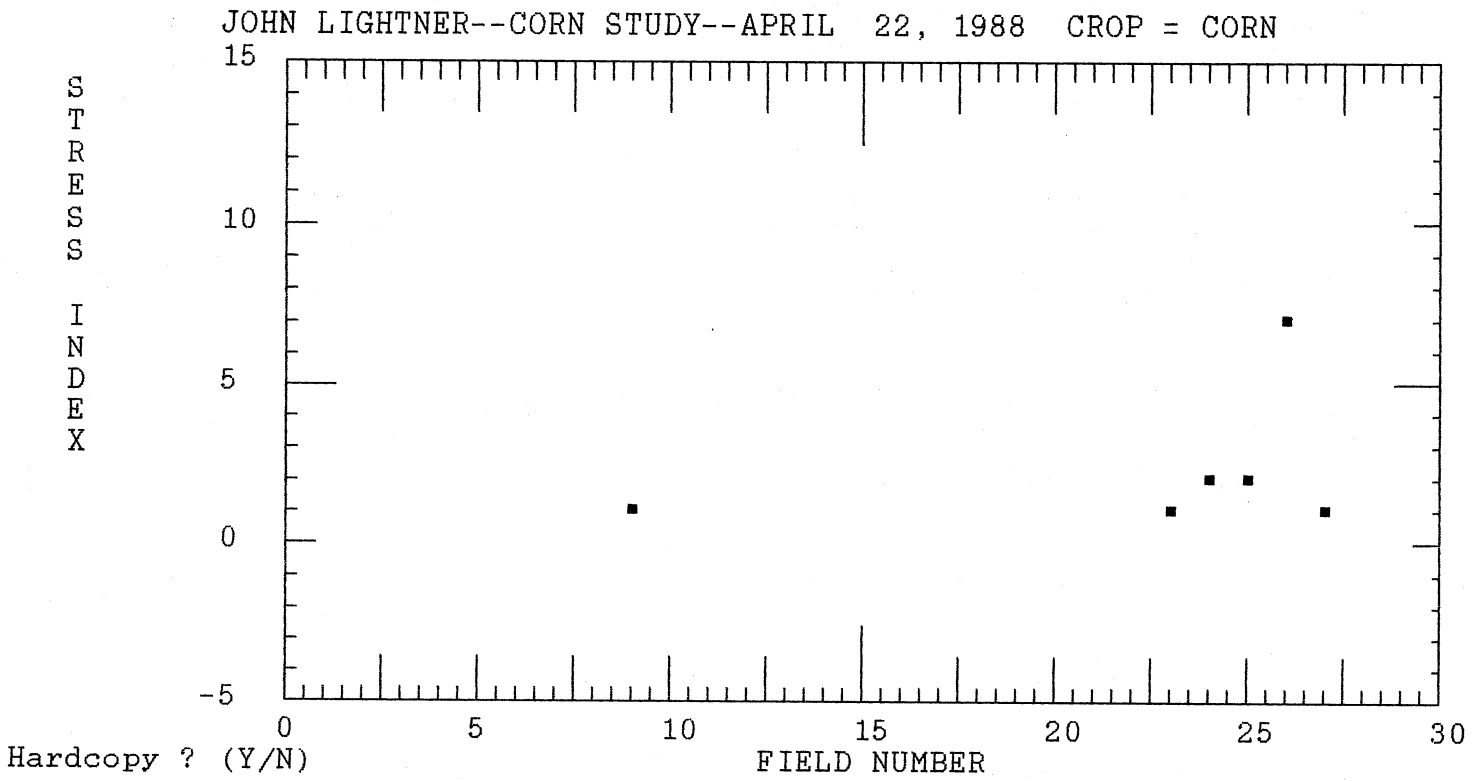
PRESS a Program Number
(Q to quit)


UTILITY OPTIONS
F = GIVE A NAME TO EACH FIELD NUMBER
P = PRINT LIST OF FIELD NUMBER/NAMES
S = PROGRAM SET-UP OPTIONS
L = LOAD DEMONSTRATION DATA
T = TEST CUSTOMER'S COMPUTER
D = FILES ON CURRENT DIRECTORY
ALT-E = EXPORT DATA TO AN ASCII FILE
ALT-I = IMPORT EXTERNAL DATA FILES
ALT-R = RESET HISTORICAL DATA FILE
E = CHECK FOR PROGRAM ERRORS
Q = RETURN TO MAIN MENU

Current Field Names:

1, OMAHA WEST
2, ''
3, OMAHA EAST
4, ''
5, DES MOINES #1--HYBRID XYZ
6, DES MOINES #2--HYBRID ABC
7, ''
8, ''
9, ''
10, ''
11, ''
12, ''
13, ''
14, ''
15, ''
16, ''
17, ''
18, ''
19, ''
20, ''
21, ''
22, ''
23, TEST AREA--VEGETABLES
24, ''
25, ''
26, ''
27, ''
28, ''
29, ''
30, TEST AREA--IRRIGATION TRIAL

Enter ↵ to leave unchanged Type a new NAME and press ↵ to change.
PRESS 'HOME' to quit ' ALT-E' TO ERASE ALL NAMES


JOHN LIGHTNER--CORN STUDY--APRIL 22, 1988 CROP = CORN
STRESS INDEX
15
10
5
0
-5
0
5
10
15
20
25
30
FIELD NUMBER
Hardcopy ? (Y/N)

SELECT:

A= ANY COMBINATION OF FIELDS (i.e. fields, 1,7,9,11)
I= FIELD INTERVAL (i.e., from fields 5-10)
C= ANY CROP (i.e., 'COTTON')

JOHN LIGHTNER--CORN STUDY--APRIL 22, 1988 CROP = ALL CROPS

PATTERN OF CANOPY TEMPERATURES

(the average canopy temp. has been subtracted)

FIELDS	1- 5	-31	-26	-21	-14	-24
FIELDS	6-10	-3	9	3	4	4
FIELDS	11-15	5	8	7	9	2
FIELDS	16-20	3	4	4	2	3
FIELDS	21-25	7	8	9	4	7
FIELDS	26-30	8	9	1	3	****

AVERAGES

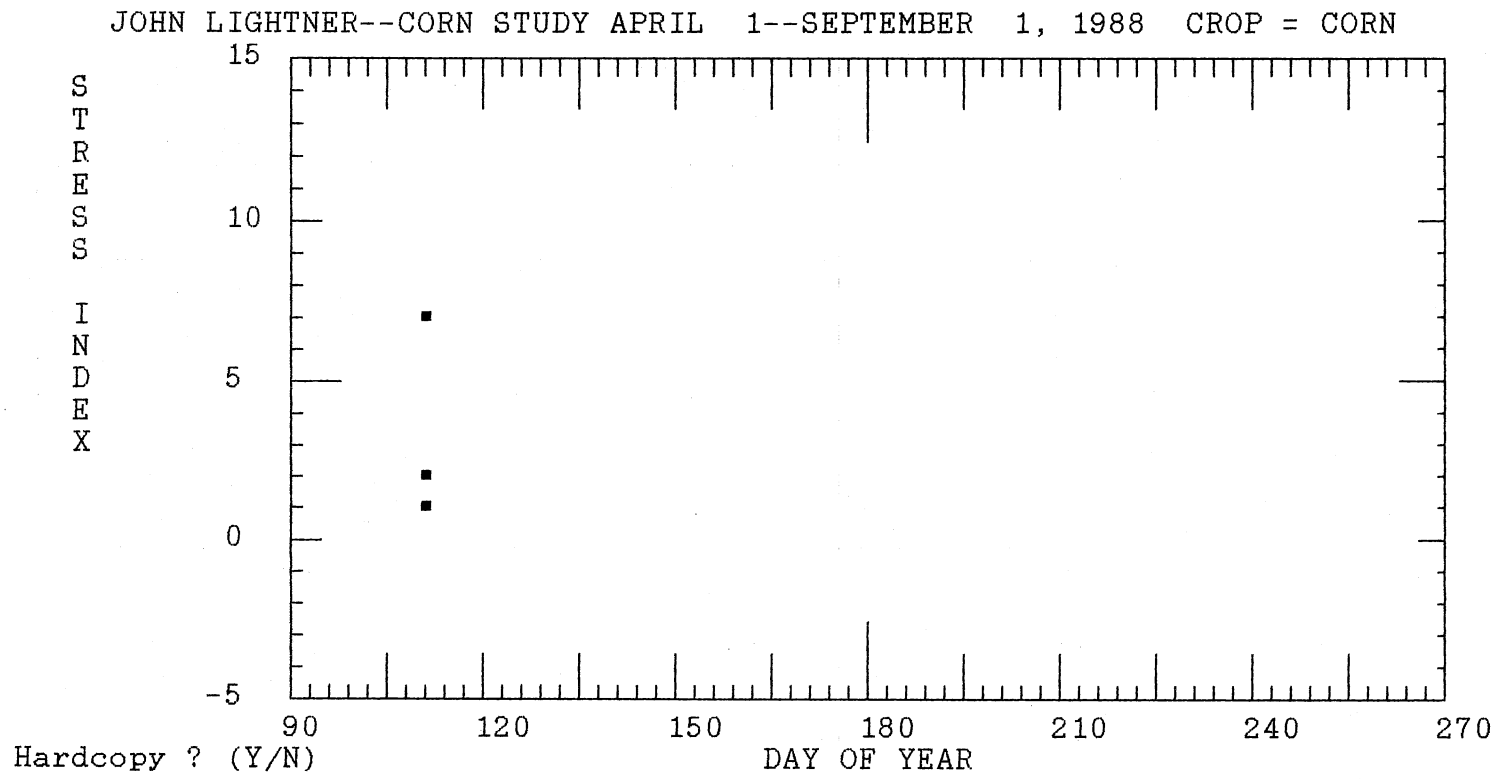
CROP TEMP = 91
AIR TEMP = 96
REL. HUM. = 33
SUNLIGHT = 85
INDEX = 2.3

PATTERN OF RELATIVE STRESS INDEX VALUES

(The overall index average has been subtracted)

FIELDS	1- 5	-1	0	1	2	0
FIELDS	6-10	-1	3	0	-1	0
FIELDS	11-15	0	0	0	0	-1
FIELDS	16-20	4	0	0	-1	-1
FIELDS	21-25	0	2	-1	0	-1
FIELDS	26-30	4	-1	-1	-1	****

HARD COPY? (Y/N)


JOHN LIGHTNER--CORN STUDY APRIL 1--SEPTEMBER 1, 1988 CROP = CORN
STRESS INDEX
15
10
5
0
-5
90
120
150
180
210
240
270
DAY OF YEAR
Hardcopy ? (Y/N)

JOHN LIGHTNER--CORN STUDY JANUARY 1--DECEMBER 1, 1988 CROP = CORN

FIELD	CROP	STAGE	DATE	TIME	CROP	AIR	RH	SUN	INDEX	SAM
09	CORN		04/22/88	13:16	094.7	101.2	88	83	01.5	2
23	CORN		04/22/88	13:30	099.6	103.1	22	90	01.4	1
24	CORN		04/22/88	13:31	095.4	103.9	23	91	01.9	1
25	CORN		04/22/88	13:32	098.4	101.2	24	92	01.6	1
26	CORN		04/22/88	13:32	099.1	100.2	24	93	06.5	1
27	CORN		04/22/88	13:32	100.1	098.4	22	91	01.2	0

PRINT ANOTHER REPORT ? (Y/N)